Augmented Beer Pong Mat

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ECE 445 Mock Design Review - Spring 2017
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1. Block diagram

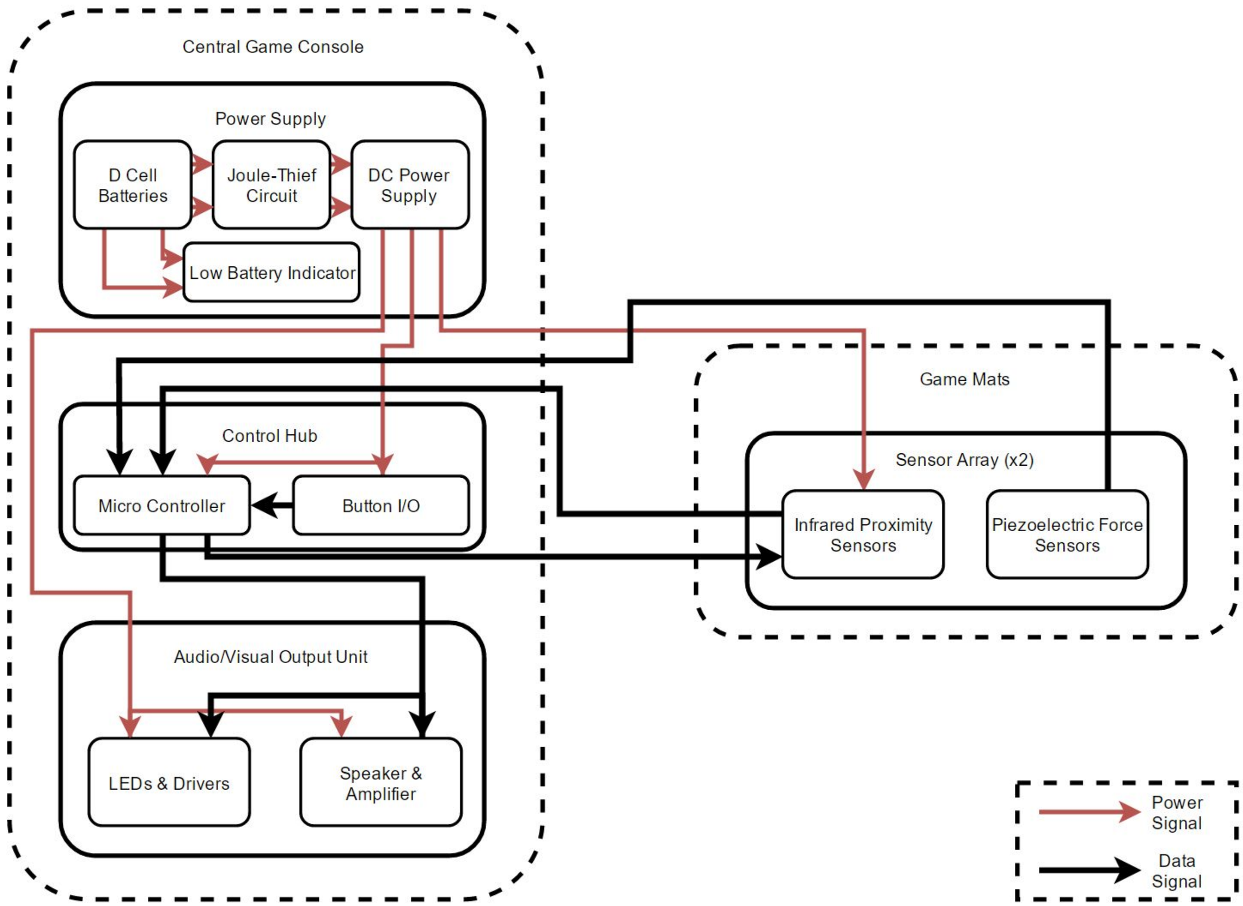
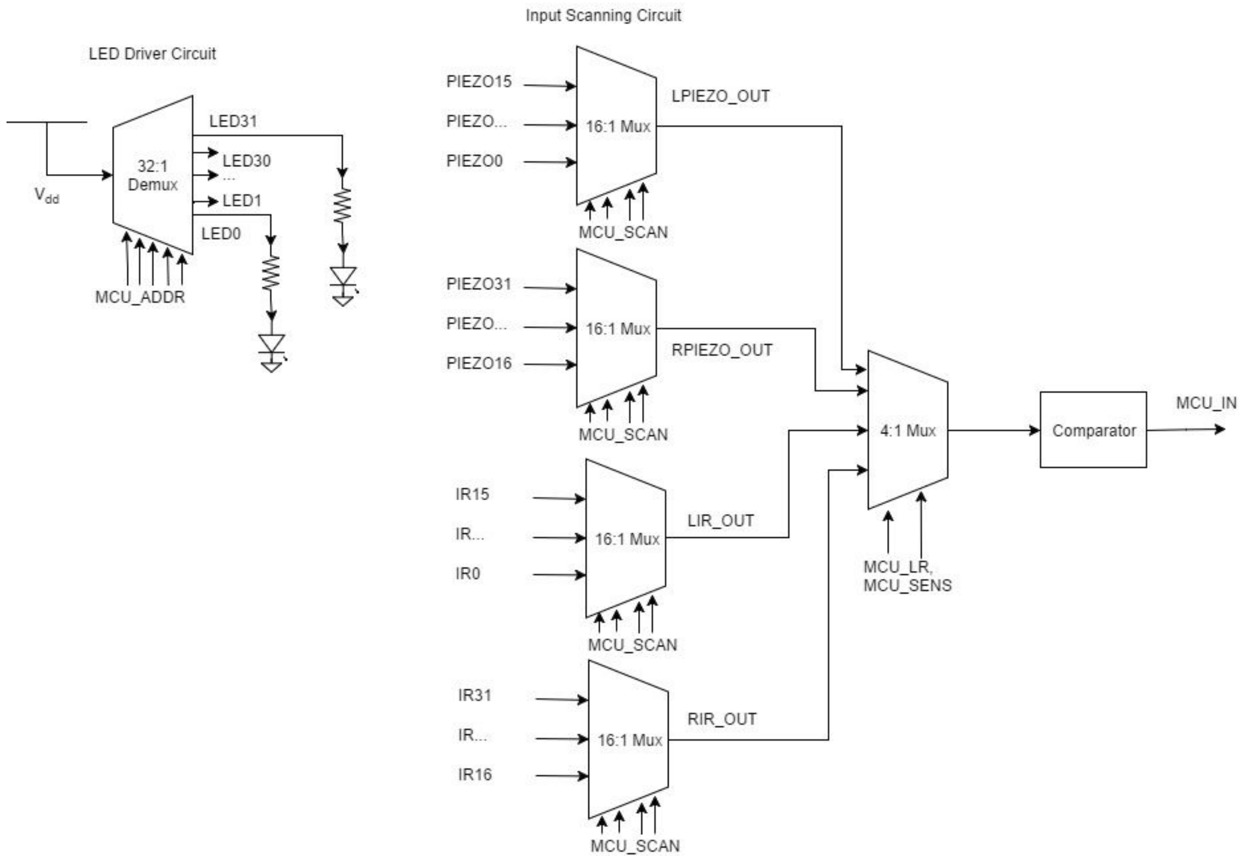


Figure 1 - System Block Diagram

2. One circuit schematic



LED Driver Circuit:
This circuit will take an input from the MCU, MCU_ADDR, which will scan through each LED that should be on. The data from the IR sensors shows which cup LEDs should remain on, based on which cups are still in play (max 20). The piezoelectric sensors and gameplay state will determine which LEDs for “one hit,” “heating up” and “on-fire.” With all of this information, the MCU will determine which addresses should be scanned through. The demultiplexer will take this address and pass VDD to the output LED.

Input Scanning Circuit:
This circuit will use MCU_SCAN bits to scan through all the IR and PIEZO sensor outputs. It will then use the MCU_LR from the MCU to determine which side of the table is currently being polled (based on game state.) It will also use the MCU_SENS signal from the MCU to determine if IR or PIEZO is currently being polled. The currently polled signal will then be routed to a comparator and sent to a digital input pin on the MCU to relay if the currently polled sensor is a 0 or 1.

3. One plot (simulation or experiment)

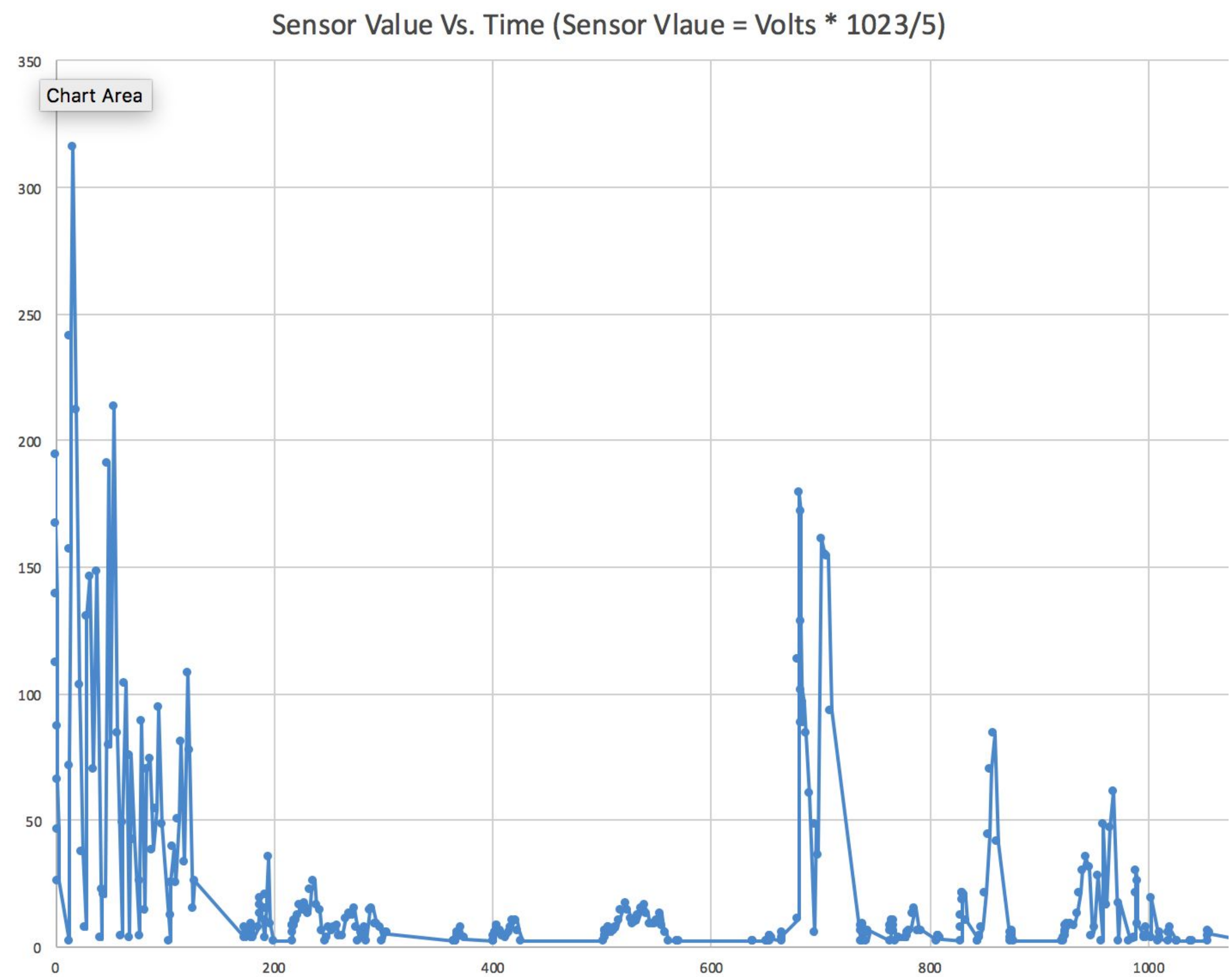


Figure 2 - Scaled Sensor Output vs Time (6kHz Sensor)

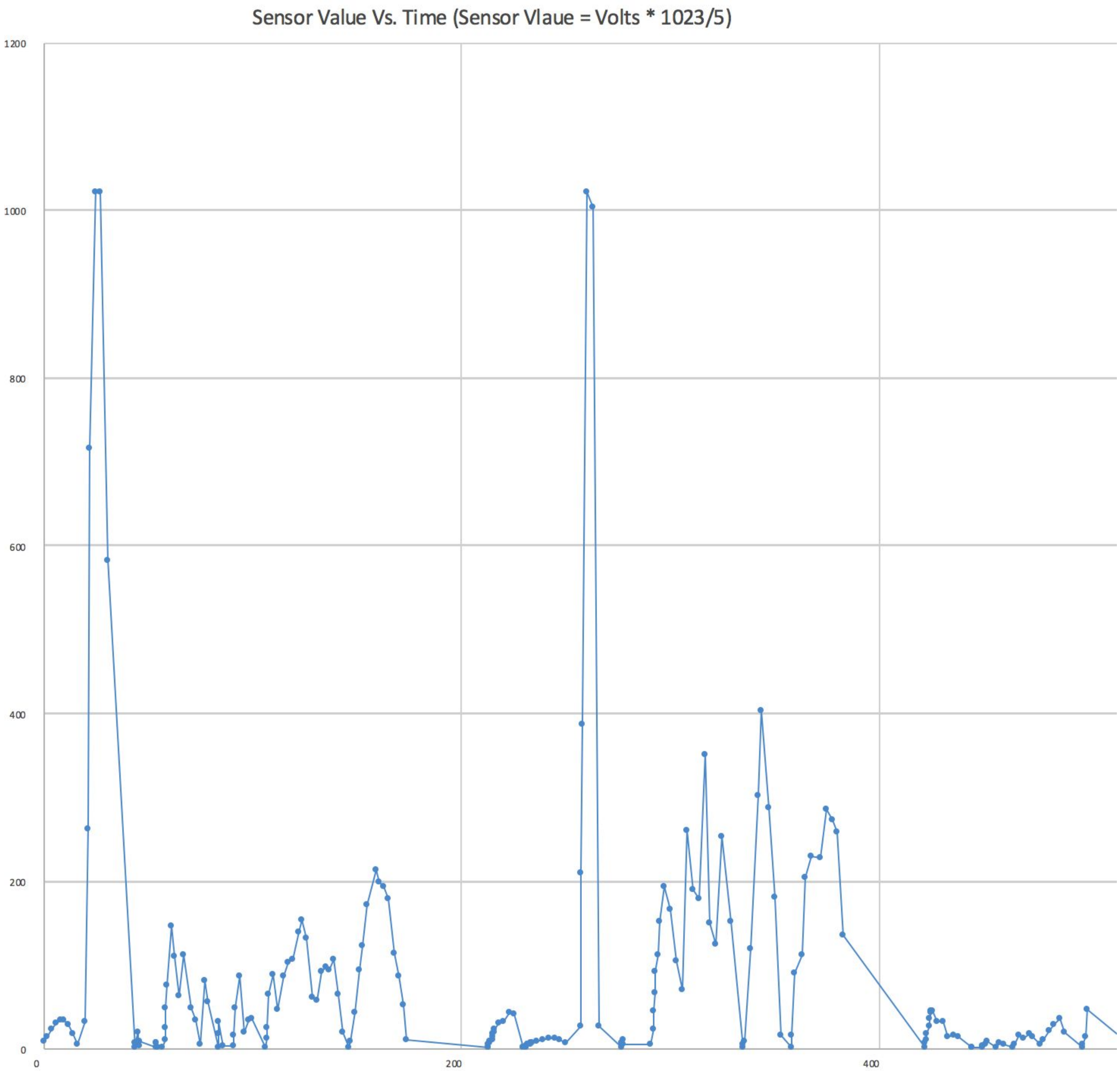


Figure 3 - Scaled Sensor Output vs Time (4kHz Sensor)

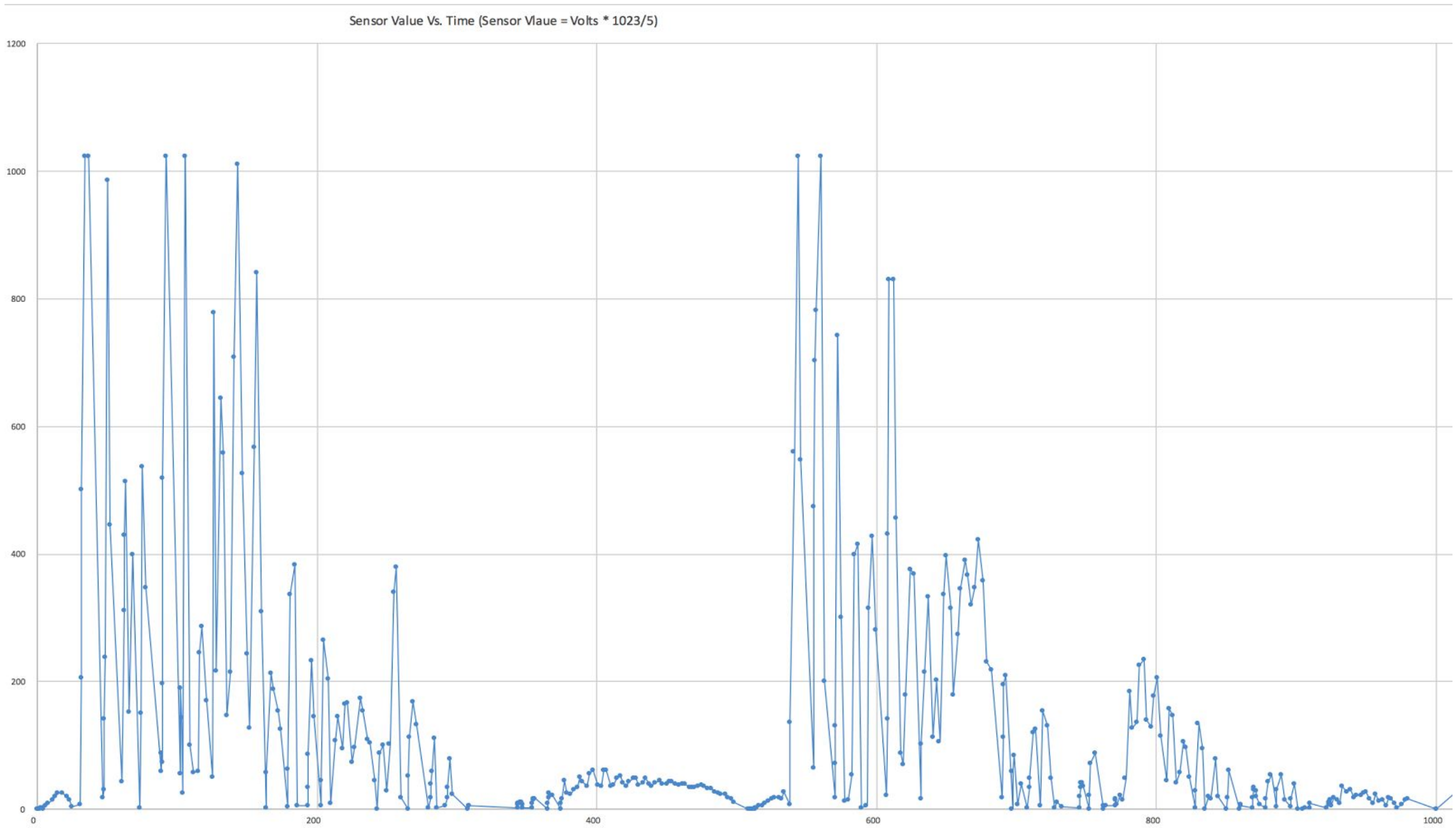


Figure 4 - Scaled Sensor Output vs Time (2kHz Sensor)

Analyzing these graphs it is apparent that the lower the frequency (or more accurately, the larger the disk and thus more give) gave us the most consistent and clear results. We did some searching and it seems that the 2kHz, 40mm piezoelectric diaphragm has one of the best size to cost ratio when buying online. We are proceeding to use the 2kHz, 40mm sensor for our project, and it is what we have based our calculations on in section 4.

4. One calculation

To accurately determine the frequency of the microcontroller our project would use, we first needed to set a high confidence, minimum scanning frequencies to pick up hits with the piezoelectric sensors. Using data compiled to create the graph in Figure 4, we were able to dial in on an adequate polling frequency that we would require from the microcontroller.

First we calculated the average time of impact above a threshold. This threshold is one we've chosen to be 1.96 volts. We chose this doing testing and comparing table bumps/impacts and cup impacts. At this threshold is where a solid table bump peaks and a solid cup impact fluctuates at a little over twice this threshold. With this in place, we were able to create Table 1 and Table 2.

Trial 1	Trial 2	Trial 3	Average
128 milliseconds	135 milliseconds	85 milliseconds	116 milliseconds

Table 1 - Average Time of Impact Above Threshold of 1.96V

Trial 1	Trial 2	Trial 3	Average
20 hits / 52 polls	17 hits / 54 polls	16 hits / 38 polls	18 hits / 48 polls

Table 2 - Number of Hits/Polls Impact Above Threshold of 1.96V

With this data we were able to find a frequency on which to poll the sensors with a high confidence of detecting cup hits.

$$\frac{48\ polls}{.116\ sec.} = 413\ polls/second$$ which we round up to $500\ polls/second$ for cleanliness

We also decided that we will scan across 10 piezo sensors but poll at the same frequency per sensor. Thus, our final calculation for the frequency of sensor switches controlled by the microprocessor should be at a bare minumum:

$$500\ polls/second * 10\ sensors = 5000\ polls/second = 5KHz$$

Looking at today's microprocessor's specifications, we think this is very achievable and with scanning, we have greatly reduced our power consumption.

5. One block description

The piezoelectric force sensor arrays perform the task of turning physical impulses with the cups into usable electrical signals for the microcontroller to monitor. These arrays will each contain 10 piezoelectric sensors upon which the in-play cups will be placed. With this many sensors per array, we are provided with an enormous opportunity for optimization. Since we have many sensors, but do not need to receive continuous (with respect to time) data, we can use a pair of 16-to-1 analog multiplexers into a 4-to-1 analog multiplexer to digitally select which one of our sensors is being read. The use of multiplexers allowed us to decrease our number of input pins (either digital or analog) from 20 down to 1. This improvement will result in increased power savings from driving pin capacitances and cost savings due to a cheaper MCU, all while providing our desired number of samples per second to offer highly accurate sensor readings.

6. Requirements and verifications for one module

The DC power supply module will be the backbone of our power supply subsystem. The task of this module is to take an AC signal as input and provide a rectified, filtered, and regulated output. This module must provide a steady 3.3V output while offering a range of currents from 0 mA to approximately 120mA with low ripple and voltage fluctuations(+/- 2%). To verify this module has the proper output, a series of tests will be performed. First, the open circuit output voltage will be measured. This will allow us to obtain the baseline readings of the output voltage and ripple. Next, we will connect an appropriately sized resistor to the output to simulate a load current equal to the maximum rated draw from our power supply. The output voltage and ripple will again be measured to ensure the output voltage is well regulated even when under heavy load. If the completed circuit passes these tests, it should serve its purpose well in our project.

7. Safety statement

As a device which will constantly be surrounded by water or beer-filled cups, we will adhere to water-resistivity to a certain degree to follow IEEE Code of Ethics, #9: “to avoid injuring others, their property, reputation, or employment by false or malicious action” [4]. We will need to obey an IP54 rating which consists of resistant against splashing of water.

Due to the inherent risks of consuming alcohol we want to reduce play time per person as to spread out the consumption to be in accordance with IEEE Code of Ethics, #1: “To accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment” [4]. One way we have found to accomplish this is by installing a streak counter on a seven segment display which would only count up to nine. If a team continuously wins over and over again, eventually their streak would come to an end and restart to zero.

Additionally, one IEEE code which may need to be violated to comply with public health and safety of underaged users would be IEEE Code of Ethics, #8: “to treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression" [4]. We will market this product only to those who are over the age of 21, in order to not glamorize drinking for those who are inexperienced and impressionable.

8. References

"The World Series of Beer Pong." *BPONG*. N.p., n.d. Web. 08 Feb. 2017. https://www.bpong.com/wsobp/

"Glowing Americana Beer Pong Table - 8 Ft - Spencer's." *Starter*. N.p., n.d. Web. 08 Feb. 2017. http://www.spencersonline.com/product/129192.uts#.WJpMnqC1BfE

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